Chemistry Background Book

Humphry Davy

Humphry Davy
1778-1829

A lively mind – Humphry Davy was born at a time when brilliant and dedicated men throughout Europe were laying the foundations of modern science. Davy was outstanding among them. Before he was thirty years old, he had discovered six new elements and, in so doing, had established electricity as one of the chemist's most useful experimental tools. He made several other important discoveries and he invented the miner's safety lamp. One of his greatest talents was his ability to popularize scientific discovery.

Full of high spirits and energy, he was an indefatigable worker in the laboratory and, when the day's work was over, he was invariably to be found at the supper tables of his many fashionable friends. Although he was first and foremost a scientist, there were few aspects of life in which he did not take an interest. He helped to found the London Zoo. He was passionately fond of fishing and, as a child, devised a special line for catching several mullet at a time. He was intimate with many of the great literary men of his day – Southey, Coleridge, Wordsworth, and Scott – and himself wrote many poems. Above all he was filled with a strong desire to help his fellow men. His aim in life was to bring about 'the amelioration of man's condition by the study and application of scientific laws'. In this he succeeded.

Boyhood in Cornwall – Humphry Davy was born in Penzance on 17 December 1778. His father was a woodcarver. He went to Penzance Grammar School but did not work hard and was often in trouble with the headmaster. But he could work with words, telling stories and writing verse.

The countryside around him, with its miners and fishermen, was at that time prosperous because of its mineral wealth, in particular of tin and copper ores. Thus Davy's interest in what

Humphry Davy (1778–1829) when he was twenty-three years old.
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substances were made of, and how they could be put to practical use, was early awakened. Such famous men as Watt and Trevithick were working in Cornwall to improve mining techniques, and each invented a steam-driven pump to rid the tin and copper mines of water. The place where Davy spent his boyhood was not only one of England's most beautiful counties but also a centre of technical progress.

Soon after Davy left school, his father died and he had to support his mother and her four other children. He was then fifteen years old. At the suggestion of a family friend, Mr Tonkin, he became apprenticed to Mr Bingham Borlase, a talented surgeon and apothecary. Responsibility made him ambitious. He started to educate himself and to improve his powers of expression by writing essays and poetry. He would make speeches to the sea and walk for miles sorting out the ideas in his head. His friends would get exasperated at his passion for discussing these ideas. 'Humphry, thou art the most quibbling hand at a dispute I ever met in my life!' said one of them. Nevertheless he *had* to talk and to write and from this period when he was learning how to express himself came his later fame as a lecturer who could make science understandable and exciting. No one wants to listen to a man with muddled ideas, and through this early self-training Davy made sure that he would be heard. He had a strong sense of his own powers and in a poem of this time called *The Sons of Genius* wrote:

Like yon proud rock, amidst the sea of time,
Superior, scorning all the billow's rage,
The living Sons of genius stand sublime,
The immortal children of another age.

The plunge into chemistry – At nineteen Davy began the experimental study of chemistry, the course his own genius was to take. Mr Tonkin's house resounded with explosions from the attic. Two books helped to set him on his way: Nicholson's *Dictionary of Chemistry* and Lavoisier's famous book, the *Traité Élémentaire de Chimie* (*Elements of Chemistry*).

Let us look at the world Davy was discovering for himself.

Chemistry was then beginning to take shape. From the end of the seventeenth century, it gradually changed from a mixture of philosophy and recipe-mongering into something more truly scientific as chemists began to develop theories based on experiments that had logical connections one with another. Connections were seen, for example, between the behaviour of acids, alkalis, and salts. The properties of gases were linked with the nature of fire – as in the celebrated phlogiston theory which postulated that a substance burned because it contained a substance called 'phlogiston' which was released on burning. But the phlogiston theory could not account for the increase of weight in a substance when it burned, and the theory was discredited by Lavoisier who showed that the air consisted of two gases, oxygen and nitrogen, the oxygen being taken up by the burning substance.

This particular discovery was only a part (although the central part) of the general overhaul of chemical theories which Lavoisier carried out. Equally important was his attempt to establish some order among the chemical elements. Like Boyle before him, Lavoisier used the term 'element' for a substance which had not at that time been broken down into anything simpler. (See the Background Books, *The Chemical Elements* and *The Periodic Table*.) Among the elements he included heat and light, and explained the production of heat during combustion by considering heat itself as a weightless element which he called *caloric*.

It was Lavoisier's theories of heat and light that prompted the impetuous young Davy, after a mere three months' study of chemistry, to produce his first piece of scientific writing. He boldly worked out an alternative scheme which was largely a mixture of other people's ideas. He emphasized the role of light and spoke of *phosoxygen*, which he considered as a union of light and oxygen. Davy suggested that when a substance burnt the oxygen part united with the combustible substance and the light was liberated. He rushed into explanations of many phenomena on this basis: the role of light in the growth of vegetation; the colour of the negro skin (light, he said,

Penzance in Cornwall, the birthplace of Davy. His statue looks down the main street.
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removes oxygen leaving a preponderance of black carbon); the production of electric sparks (minute particles of light being forced together into a small space and giving a local bright appearance); and much else.

In contrast to his theory of light, Davy's theory of heat was in part respectable. The idea that heat was a manifestation of the motion of the particles of which a body was composed went back to Francis Bacon and Robert Boyle in the seventeenth century, and Count Rumford had carried out experiments to test the theory while Davy was still a boy. Davy was not content with this theory and combined it with another: that the products of combustion had a smaller capacity for heat (in modern terms, a smaller *specific heat*) than the reactants; therefore, because the heat from the reactants was transferred to the products during combustion, the temperature of the products must be higher.

Davy's ideas showed a lively imagination, a necessary ingredient of every great scientist, but they were far from convincing at a time when sound logic and careful experiment were already essential qualities in scientific work. Ideas had to be backed by experimental evidence. It would have been better had Davy locked his papers in the drawer of his desk. As we shall see, he was persuaded to publish them, with disastrous results.

The laboratory in Bristol–During his apprenticeship with Mr Borlase, Davy's gift for experimenting came to the notice of a wealthy landowner, Davies Giddy, who let Davy see his library and examine chemical apparatus in use at the local copper works. Giddy was, among other things, a mathematician, an antiquarian, and, for a great part of his life, a member of Parliament. He eventually succeeded Humphry Davy as President of the Royal Society.

Davy was also encouraged by Gregory Watt (son of the famous James Watt) who stayed with Davy's family in 1797. Watt encouraged Davy's interest in chemistry and geology and had much to do with fostering his lifelong love of poetry. Through Giddy and Watt, Davy's gifts came to the notice of Dr Thomas Beddoes of Bristol. Dr Beddoes was impressed, and offered the nineteen-year-old Davy a position as superintendent of a laboratory he was setting up in Bristol to study gases for their medicinal effects. Gases played a leading part in the rapid advance of chemistry at this time and Beddoes was following a long tradition in seeking links between chemistry and medicine.

Shortly after taking up his position at Bristol, Davy was persuaded by Dr Beddoes to publish his ideas on heat and light. They appeared in 1799, and Davy was badly mauled by the critics. This was a mortifying experience for an ambitious and sensitive young man who thought himself to be on the threshold of fame. Davy always looked back on his impetuosity with shame. But he learnt his lesson. Henceforth his theories were guided by experiment. Indeed it was rather as an experimenter than as an exponent of new theories that he made his reputation.

At Bristol Davy set to work to examine the properties of nitrous oxide, a gas which had been discovered some years earlier by Priestley. Davy had already made small amounts of nitrous oxide at Penzance, but at Bristol he made it in its pure form and examined its chemical composition, obtaining an accurate estimate of the proportions of nitrogen and oxygen. There had been some argument about the medical properties of nitrous oxide, and one theory held that it possessed the power of spreading disease. Davy decided the only way to test this was to try it on himself, and breathed two quarts of it from a silk bag. He found it was safe enough, but was astonished at the effect it produced. It was like being drunk or semi-delirious, but in a very pleasant way. Many other people tried it: some became so uncontrollably hilarious that the gas got the name of 'laughing gas'.

The most striking effect of the gas that Davy noticed was that it suppressed physical pain. (It stopped one of his wisdom teeth aching while he breathed it.) Davy wrote 'As nitrous oxide . . . appears capable of destroying physical pain, it may probably be used with advantage during surgical operations'.

Cartoon, drawn by Gilray, of a lecture at the Royal Institution in 1801. The subject of the lecture is gases, in particular, the gases of the air. Davy, the young man behind the bench squeezing a pair of bellows, had already contributed to knowledge of gases through his work on nitrous oxide. Professor Garnett, whom, in the same year, Davy was to succeed as Professor of Chemistry at the Royal Institution, is administering gas to a courageous member of the audience. Count Rumford, founder of the Royal Institution, is standing on the right, smiling benignly. *Reproduced by permission of the Royal Institution.*

Unfortunately Davy's suggestion was not taken up until almost fifty years later when an American dentist, Horace Wells, did use it as an anaesthetic; but, by then, ether had come into use for this purpose and it was some time before 'laughing gas' became established as an anaesthetic for minor operations. Nevertheless, Davy had made an interesting discovery and with it gained something of a reputation as an experimenter. He pursued his studies of gases and was lucky not to kill himself with some experiments on carbon monoxide.

Triumph in London – Davy's next move was to the Royal Institution in London, and it was there that he established himself as one of the foremost scientists of his day. The Royal Institution had been founded in 1799 by Count Rumford, a man distinguished in public affairs. Rumford's purpose in starting the Institution was to apply science to such everyday needs as the preparation of 'cheap and nutritious foods for feeding the poor' and 'improving the construction of cottages, and cottage fireplaces and kitchen utensils'. The Institution also aimed at fostering an interest in science among the well-to-do classes and among artisans, for people were becoming curious about what science could do. Davy was recommended to Rumford as a promising young man and, with the consent of Dr Beddoes, Rumford's friend, was appointed lecture assistant at the Institution. The first professor of chemistry, Dr Garnett, had begun well but, after serious illness and several disputes with Rumford, had to resign. Davy was appointed by Rumford to take Garnett's place.

From his very first lectures in 1801 Davy was a great success. Hundreds of people packed into the lecture room to hear this eloquent young man talking about chemistry and its applications. He was always deeply excited by his subject and managed to communicate this excitement to his audience. Wealthy and influential people came to listen to him, and his charm and good looks soon made him sought after by the fashionable leaders of society. When asked how the clever men in London compared with Davy, the poet and philosopher Coleridge replied: 'Clever men? Our own Humphry could eat them all.' Such praise greatly pleased the ambitious young Davy but, if it made him rather vain, it did not distract him from his scientific work.

Davy's laboratory was in an underground room below the Royal Institution; and though he was neat and methodical in the lecture room, in his laboratory he was quite another person. He worked very fast; invariably the laboratory was in a state of chaos, and he often carried on several quite unconnected experiments at the same time. In contrast to the painstaking Michael Faraday, who was later to become his assistant, he was all brilliance and dash. Yet, despite his unconcern for detail, he achieved some remarkable results. For some time his experimental research, selected by the Managers of the Institution, was on such subjects as the tanning of leather or the analysis of minerals. But by 1806 he was able to take up once more some interrupted work on electricity.

Electricity – During the eighteenth century there had been much progress in the study of electricity but only static electricity was known. This was produced by friction, often continuously by a machine.

In 1791 Galvani's experiments on frogs and animal electricity attracted attention. (See the Background Book, *Discovery of the Electric Current*.) Then, in 1800, details of Volta's electric battery or pile were published. A set of alternate plates of zinc and silver separated by damp linen or

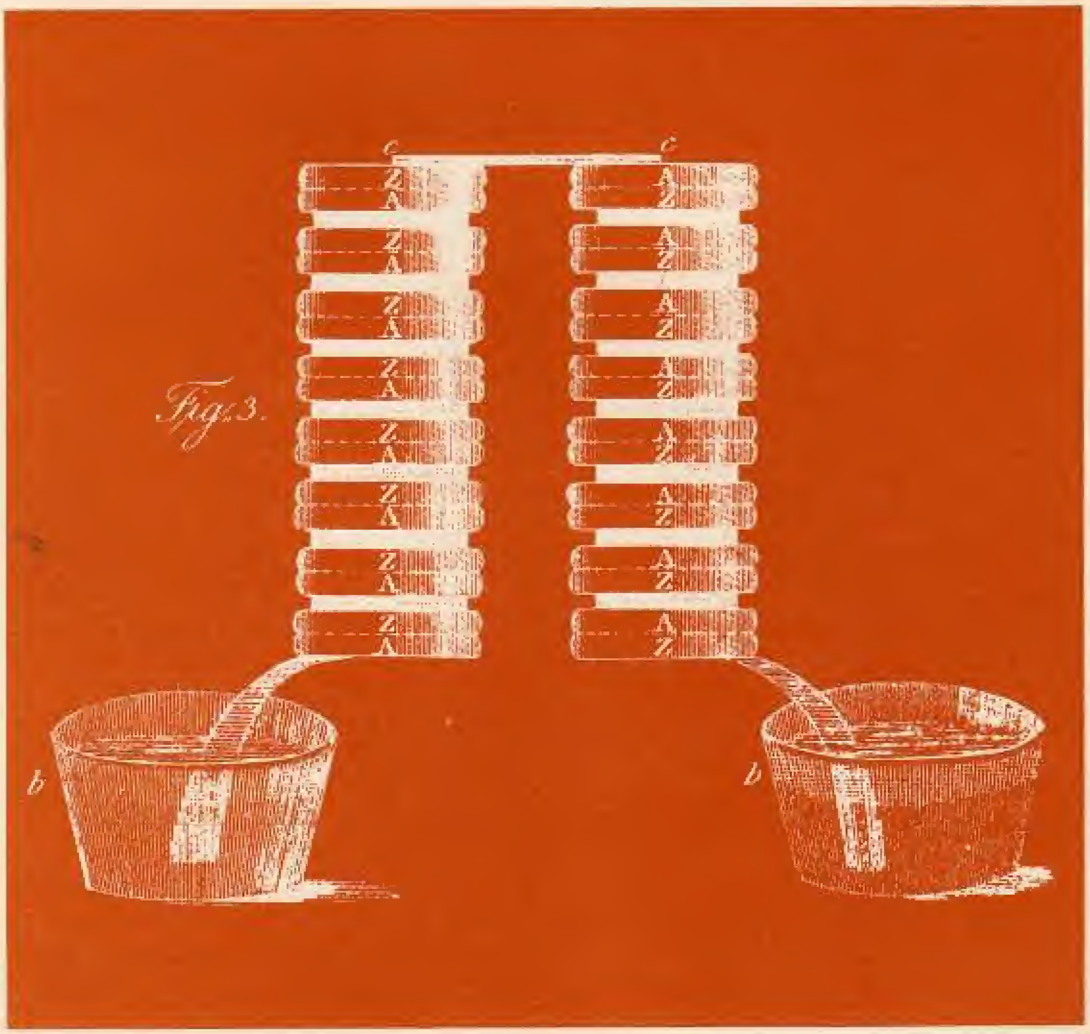
paper produced electricity spontaneously without external action. Almost immediately Nicholson and Carlisle made a very remarkable observation when they connected a wire from the bottom plate of a Voltaic pile to a drop of water on the top plate: they saw that bubbles of gas were formed.

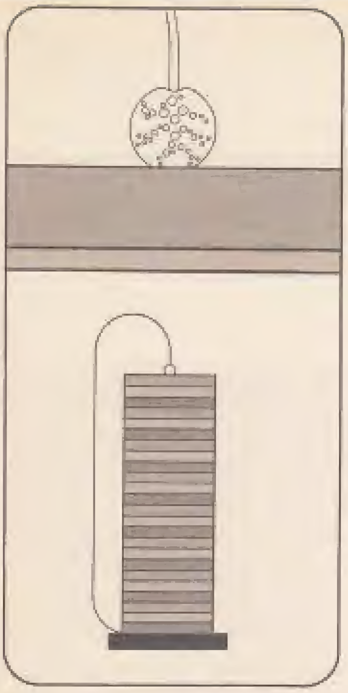
Like many other scientists, Davy followed up this experiment. He had already found in 1800, while still at Bristol, that the amounts of hydrogen and oxygen produced from water by electrolysis were in the proportion 2:1 by volume, which is the same as the proportion in which hydrogen and oxygen combine to form water. When the composition of even as simple a substance as water was still in dispute, this discovery was significant. With caustic potash, electrolysis produced hydrogen and oxygen – exactly the gases obtained from water. This result was a surprise and for a long time there was no explanation for it.

Apparatus of the kind used by Davy for estimating the quantity of carbonate in soils. A weighed quantity of soil was put in the left-hand flask and acid dripped on to it through the funnel. Carbon dioxide, from the reaction of carbonates present in the soil with the acid, expanded the balloon in the centre vessel. This vessel was filled with water, and the expansion of the balloon caused water to be displaced into the cup on the right. The volume of water displaced was equal to the volume of carbon dioxide that had been generated. Davy's first work at the Royal Institution was devoted to such practical applications of chemistry as the improvement of agriculture. In his Introductory Discourse to the Royal Institution in 1802, he expressed the far-sighted view that 'though the common soil of the earth will produce vegetable food, yet it can only be made to produce it in the greatest quantity, and of the best quality, in consequence of the adoption of methods of cultivation dependent upon scientific principles ... and his (the farmer's) exertions are profitable and useful to society, in proportion as he is more of a chemical philosopher.' *The Museum of the History of Science, Oxford.*

Because electricity produced chemical reactions, Davy reasoned that electricity might very well be the cause of chemical affinity, and that in some form or another it might be an essential constituent of all matter. This was a new and fundamental idea, the full meaning of which has only been worked out in the twentieth century, but it had a profound effect on science right from the time of its discovery. It was so striking, in fact, that, although England and France were at war, the French Institute awarded Davy a prize founded by Napoleon to be given each year for the most important work

Volta's original pile in which pairs of zinc discs (Z) and silver discs (A) are separated by paper strips.
Burndy Library.





Nicholson and Carlisle were the first to make practical use of a Voltaic pile. They built a pile (shown here diagrammatically) consisting of thirty-six silver half-crowns alternating with thirty-six zinc discs, separated by paper soaked in salt water. With platinum wire they connected the bottom plate of the pile to a drop of water on the top plate. Immediately gas bubbles began to form (see enlarged diagram of water drop); on investigation, the gas bubbles proved to be oxygen and hydrogen. Davy said of this experiment: 'The origin of all that has been done in electrochemical science was the discovery by Nicholson and Carlisle of the decomposition of water on 30 April 1800.'

Gold cups, connected by threads of asbestos, in which Davy electrolysed distilled water under vacuum and showed that no acid or alkali was formed. Before this experiment in 1806, the appearance of acids and alkalis during the electrolysis of water had been a mystery. They came from the air or from impurities in the vessel.

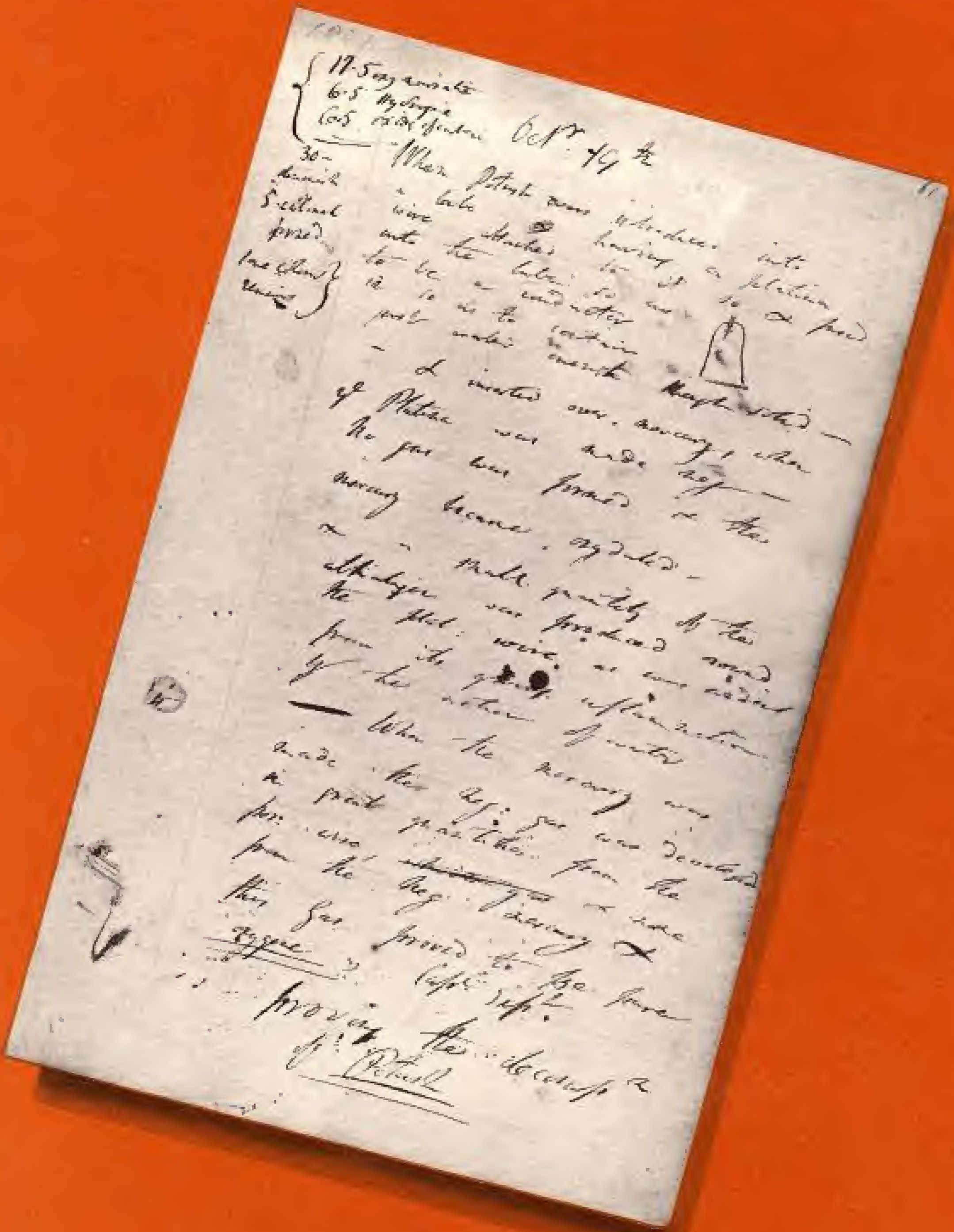
in electricity. Some people thought Davy ought to refuse the prize but, as he wrote to a friend, 'If the two countries or governments are at war, the men of science are not!' He believed, as many famous scientists do today, that science should be above national rivalry.

A year later, in 1807, Davy crowned his electrical work with a discovery which really deserves to be called sensational. He came back to the electrolysis of potash using, not a solution, but some solid potash, barely moist. At the point of contact of the platinum wire there appeared small globules of a shining white metal which rapidly burnt in air. This was potassium. In his notebook he wrote in large letters 'Capital Experiment', and danced about the laboratory with joy. Within three days, he had isolated by the same method another metal from caustic soda. He called these new metals eventually potassium and sodium. But the pace at which he had been working proved too much for him, and he collapsed from the strain.

After a serious illness lasting several months, Davy returned to his laboratory to continue work with the Voltaic pile which, by his successful decomposition of potash and caustic soda, he had shown to be such a useful tool for the chemist. Following up suggestions of the Swedish chemist Berzelius, he used a mercury electrode to obtain amalgams of two metals from the minerals baryta and strontia. By distilling the mercury, he obtained the free metals which he called barium and strontium. He could not obtain pure calcium or magnesium by this method, but the connections were clear enough for his assertion of four new elements to be justified. Six new elements within two years was good going.

Davy's attempts to decompose other substances with his pile were less successful. He believed that nitrogen was not an element and wrote to a friend: 'I hope, on Thursday, to show you nitrogen torn to pieces in different ways.' Lavoisier had defined an element as a substance that could not be broken down into anything simpler. Davy hoped to show that nitrogen could be broken down. He tried for several months but failed. He also failed to decompose carbon, sulphur, and phosphorus which, again, he was wrongly convinced were not elements.

To help in this work, he persuaded the Royal Institution to build a bigger and more powerful electric battery. With it he gave a spectacular demonstration in which he struck a spark between two pieces of charcoal connected to the poles of the



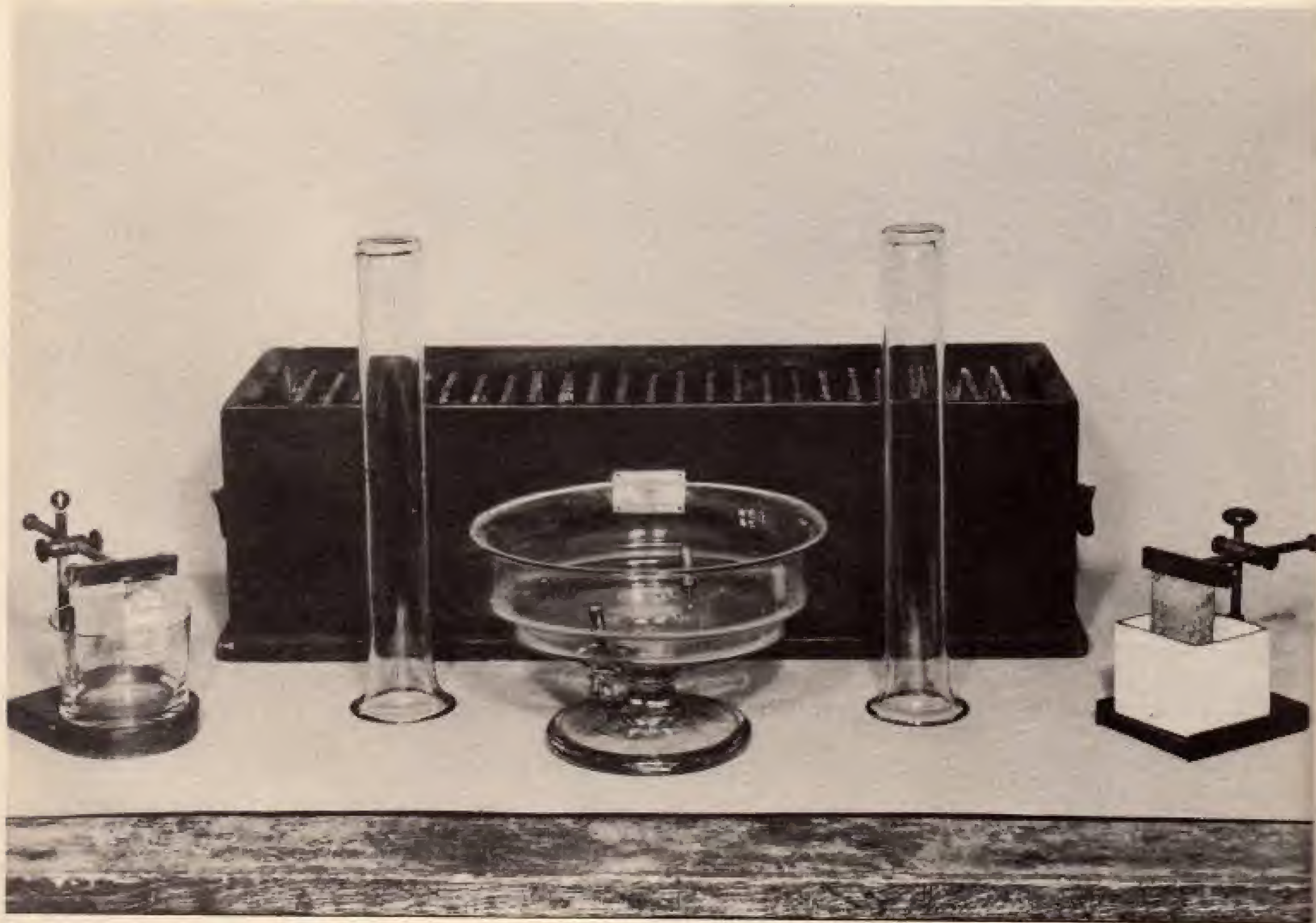
Davy's notes of the famous experiment in which he decomposed potash and was led to the discovery of the metal potassium. The notes read as follows:
'October 19 (1807) When potash was introduced into a tube having a platina wire attached to it so, and fused into the tube so as to be a conductor i.e. so as to contain just water enough though solid – and inserted over mercury. When the Platina was made negative, no gas was formed and the mercury became oxydated and a small quantity of the alkaligen was produced round the platinum wire as was evident from its giving inflammation by the action of water. When the mercury was made the negative, gas was developed in great quantities from the positive wire and none from the negative mercury and this gas proved to be pure oxygene. Capital Experiment proving the decomposition of potash.'
Reproduced by permission of the Royal Institution.

battery. Electric light was for the first time seen to be a possibility, but it was many years before the possibility was realized.

Oxymuriatic acid – Davy's next important research was of a different kind. His work with electricity had produced substances which nobody had seen before. Davy now showed that a substance every chemist knew very well as a chemical compound was, in fact, an element. This was chlorine.

Chlorine had been discovered by Scheele in 1774. Its compound with hydrogen, the substance we call hydrochloric acid, had been well known for hundreds of years. It was called *muriatic* acid (from the Latin for *brine*).

Lavoisier had believed oxygen to be present in all acids; and in fact the name Lavoisier gave this gas means 'acid-maker'. What, then, was the nature of chlorine? It was made by oxidizing 'muriatic' acid. Thus, when Lavoisier called it 'oxymuriatic' acid, everybody agreed. In 1810 Davy decided that there was only one argument in favour of believing 'oxymuriatic' acid to be a compound containing oxygen. This was that all the other acids that were known were made from



Davy demonstrates in 1809 the arc light formed between two pieces of charcoal attached to the poles of his battery, and the audience witnesses electric lighting for the first time.
From 'An Illustrated History of Science' by F. Sherwood Taylor.

The battery, containing over 2000 plates, is shown in the cellar beneath the lecture room.

oxides, for example, from oxides of nitrogen or sulphur. He carried out experiments aimed at extracting the oxygen from compounds containing it. He heated the 'oxymuriatic acid' with white-hot charcoal; he passed electric sparks through it; he examined its compounds with tin and phosphorus and could obtain no oxygen compounds from them. He pointed out that, although oxygen could be obtained from oxymuriatic acid, this only happened when water was present. After considering such evidence as this, Davy summed up by saying that 'oxymuriatic acid' probably contained no oxygen, but was an element (the one we now know as chlorine).

Thus a prominent defect in Lavoisier's ideas about acids was removed, for it was recognized that muriatic acid (i.e. hydrochloric acid) was a compound of chlorine and hydrogen containing no oxygen. This led the way to a new idea that an acid is a compound containing hydrogen and that the hydrogen can be replaced by a metal to form a salt.

Man of fame – In 1812 Davy married a rich widow, a cousin of Sir Walter Scott. He was thirty-three years old and at the height of his fame. A knighthood was conferred on him by the

Some of the original apparatus with which Davy carried out his electrochemical experiments. The battery (at the rear of the photograph) is a modified version of Volta's original pile. Zinc and copper plates are contained in a wooden box which is coated with resin to hold the liquid electrolyte.
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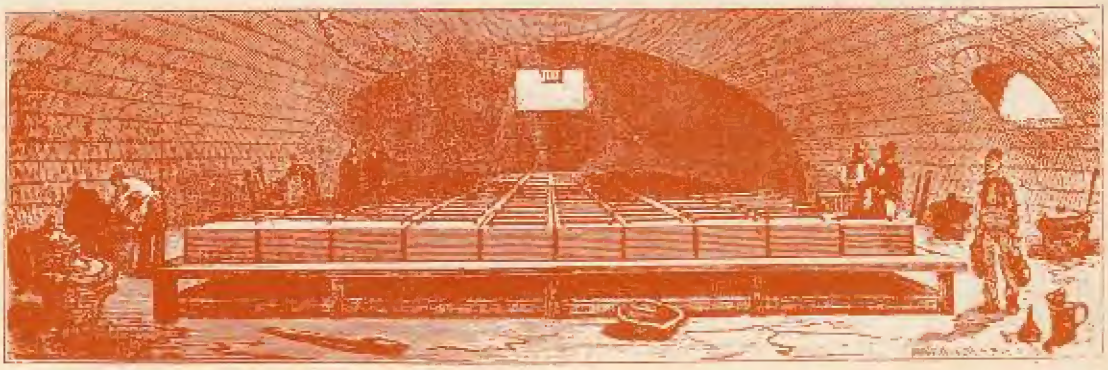


Prince Regent. For several years he had been a prominent member of the Royal Society which was (and is to this day) the leading scientific society in Britain and second to none in the world. Later Davy was to become its president.

Shortly after his marriage he resigned his professorship at the Royal Institution, but retained an honorary post and continued to do research work in the laboratories. During that period, he was approached by a young bookbinder's apprentice called Michael Faraday, who had developed an interest in the books he was binding, attended some of Davy's lectures

The library at the Royal Institution in 1809. Thanks largely to Davy, the Institution had by then become established as a place for important scientific research.
Reproduced by permission of the Royal Institution.

Davy's writing in his laboratory notebook reflects the excited haste of much of his experimental work. Here is a page of instructions for some experiments he is doing. (13 September 1809.) 'At least a whole morning must be devoted to the inspection and ordering of the Voltaic Battery — For Thursday i.e. tomorrow the experiments in the morning are on the excitation of Radiant Heat and Electricity in different gases — For the experiments on Friday which will be on Tellurium there are wanting very pure Hydrogen. Two bottles of new very pure oxymuriatic gas. Two new stopcocks cemented into retorts with stoppers either green or white. Some tubes of this bore O or near it closed at the end and 6 inches long. A spirit lamp made from a phial of large bore and the tube larger than that at present used.' *Reproduced by permission of the Royal Institution.*

and at once wanted to work for him. Davy took him on as his assistant and it has often been said that Faraday was his greatest discovery. In 1813 he took Faraday with him on a tour of the Continent where they met such celebrated scientists as Ampère and Volta. During the tour, Davy showed that a newly isolated substance was an element (iodine) similar to chlorine. (See the Background Book, *Michael Faraday*.) His invention of the miner's safety lamp, through which the name of Davy was to become a household word, was still to come.

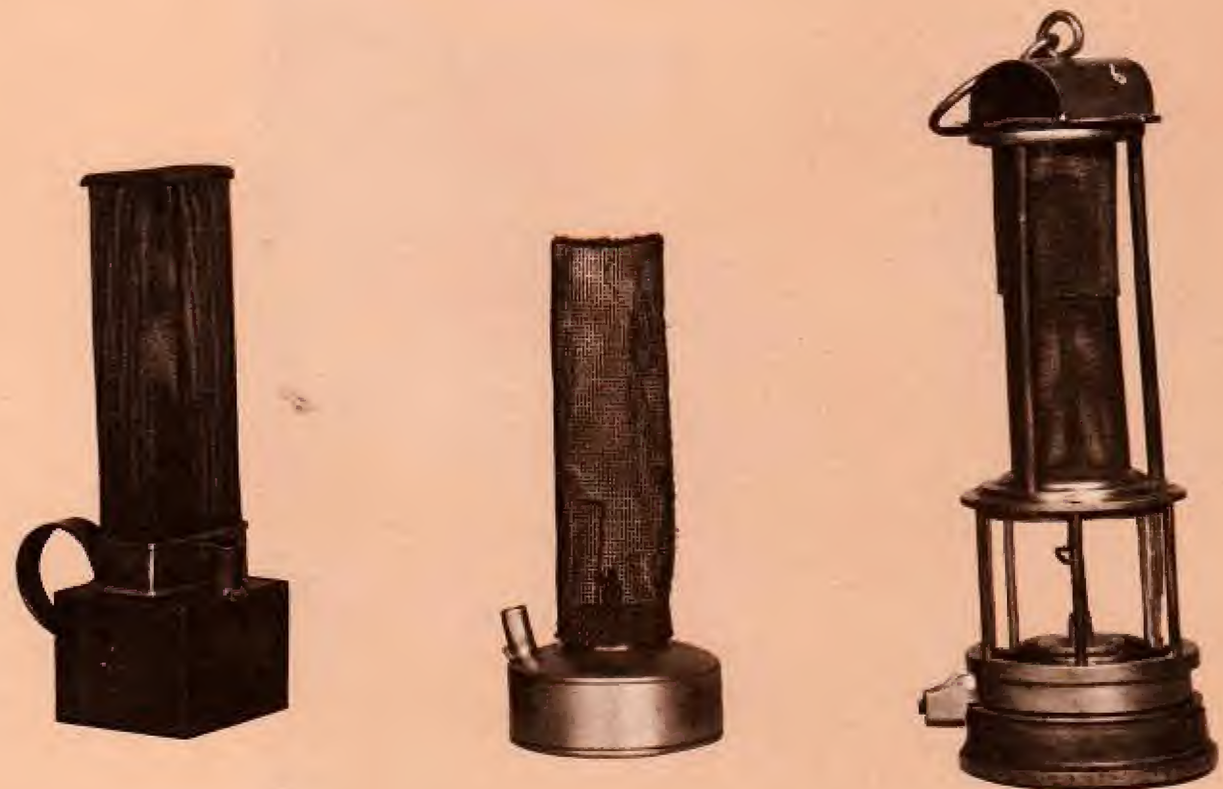
The Safety Lamp – The miner's safety lamp is one of those blessings of science which seems to have had no unpleasant consequences. Some inventions are made by luck or a quick idea. Davy's invention in 1815 was made by careful study of a technical problem.

Coal mining had been for years one of the country's most important industries. The miner found his way by open lights, candles or oil lamps. As mines went deeper, explosions caused by gas became more dangerous. A society was formed to try

Experimental versions of the miner's safety lamp made by Davy.
Reproduced by permission of the Royal Institution.

to improve conditions and Davy was asked to help. He replied as follows: 'It will give me great satisfaction if my chemical knowledge be of any use in an enquiry so interesting to humanity, and I beg you will assure the Committee of my readiness to cooperate with them in any experiments or investigations on the subject.'

Davy started by visiting mines. Then he began to study flames and explosions in his laboratory. He found that gas explosions would not pass through narrow tubes, especially if they were made of metal. He reasoned that this must be because metal (which is a good conductor of heat) carried the heat of the burning gases away from the part already on fire. The next part, therefore, would not get hot enough to burn. He then tried a wire gauze, which can be thought of as a lot of short narrow metal tubes side by side. This he found to be very effective. The inflammable gas can be burning on one side of the gauze but the gauze conducts the heat away so well that the gas on the other side is not raised to a temperature at



Zinc anodes fitted to a large ocean-going tanker to protect the hull against corrosion. This kind of protection was first envisaged by Davy.

which it will catch fire. Davy constructed lamps in which the flame was surrounded by a metal gauze.

It was found that the Davy lamp not only burned safely but also gave a warning. This was because the inflammable gas which passed through the gauze to the inside of the lamp burned with a bright flame which looked quite different from the ordinary oil flame. The lamp saved countless lives. It meant safer work, and therefore more productive work. The coalowners were saved so much money that they gave Davy a present of a magnificent set of silver plate; but Davy, who had refused to accept any money payment for his work, left even this, in his will, to the Royal Society. He wanted it to pay for an annual medal awarded for any important chemical discovery.

George Stephenson, later to be famous for his work as a railway engineer, also came close to designing a safety lamp along the same lines but his work was incomplete and unscientific. The real credit goes to Davy.

The last years – Sometimes correct reasoning results in a failure. Davy's last major piece of work – which would have been, like the safety lamp, of practical importance – was such a failure. Ships used to have their wooden hulls sheathed with copper which would corrode. The Admiralty asked Davy to try to prevent this and he suggested installing protective bars of another metal such as iron or zinc. The intention was to form a small battery in which the iron or zinc component would corrode first. (See the Background Book, *Corrosion of Metals*.) Davy's suggestion worked and the copper stayed bright, but he had not realized that the chemicals formed by the corrosion of copper were poisonous to barnacles and seaweed. When the copper stayed uncorroded, barnacles grew and slowed the ship down.

Davy's last years were not very productive. The failure of the experiments on ship-protection saddened him. He travelled restlessly and died in Geneva on 29 May 1829, at the age of fifty. As well as all the benefits he brought to science and mankind, he left us this thought: 'In the physical sciences, there are much greater obstacles in overcoming old errors than in discovering new truths, the mind being in the first case fettered, in the last perfectly free in its progress.'

Questions

1. To what do you attribute Davy's success as a scientist?

2. When Davy passed an electric current through a solution of potash (potassium hydroxide) in water, hydrogen and oxygen were liberated at the poles of his battery. When he passed an electric current through fused (molten) potash, potassium metal was liberated at one pole and oxygen at the other. Explain.

3. Why did Davy fail to show 'nitrogen torn to pieces in different ways'? Over a hundred years later, Lord Rutherford succeeded in changing a minute quantity of nitrogen into oxygen. How does this tie in with Lavoisier's definition of an element as a substance that cannot be broken down any further?

4. The Swedish chemist Berzelius told his cook not to speak of 'oxymuriatic acid' any more. 'Thou must call it chlorine, Anna, that is better!' Why did Berzelius make this remark?

5. Do you think Davy should have accepted the French Institute's award of the Napoleon medal at a time when England and France were at war?

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